

## Hand-made paper for paper restorers and attempts to manufacture paper for the conservation of silk fabric

Józef DĄBROWSKI\*, Henryk GONERA, Marzanna MARCINKOWSKA and Anna D. POTOCKA

### Summary

*The permanence of early European hand-made paper is discussed. The addition of lime (i.e. calcium hydroxide) to the beating process may be considered the main secret of the genuinely European art of paper-making invented in medieval Italy. The residue of lime in paper would react with the animal glue used for sizing, making its proteinaceous substance much less accessible to micro-organisms. The lime also reacted with atmospheric carbon dioxide producing particles of calcium carbonate in paper, even though no pigment was added in the manufacturing process. Having gained this knowledge, we began to manufacture hand-made paper for paper restorers. The attempts to make paper for the conservation of silk fabrics are also mentioned.*

The Pulp & Paper Research Institute (ICP) in Łódź is the only industrial research centre established in Poland to carry research and development activities in papermaking, in the broad meaning of this term, covering pulp & paper technology, paper processing and special technologies, including the protection of the environment. To help paper restorers we have made attempts to start small-scale manufacture of permanent hand-made paper. However, the most important question was: how can one explain the excellent permanence of ancient European hand-made papers? The fact that they were made from rag-stock cannot alone account for their durability. It was shown some forty years ago that during an accelerated ageing process chemical kraft wood pulps, whether bleached or unbleached, were as stable as rag-pulps, provided that their initial degree of cellulose-polymerisation was high (1000-1200 plus) (FAULHABER, 1956).

Quite recently, T. Barrett was able to demonstrate the important role played by the amount and condition of gelatine in gelatine-sized papers (1400-1799) in relation to their strength and permanence. However, a further question arises as to why gelatine has not degenerated over the centuries? Confirming Barrow's earlier work, Barrett also showed that the oldest (fifteenth century) paper, still in good condition, contained levels of calcium that were higher than those in the newer paper. But Barrett's explanation of the alkalinity of early European papers is inconclusive. He

writes: 'It is not clear if this resulted from papermaking practice (the addition of chalk to keep the paper colour whiter) or by chance (such as a mill water supply that happened to be naturally high in calcium or magnesium carbonate)' (BARRETT, 1996). The publications describing the beginnings of papermaking in Fabriano (GASPARINETTI, 1953), or the Italian technique of the craft (HILLS, 1992), do not provide insights for the discussion of the above questions. However, the first documented use of filler (china clay) in European papermaking took place in England in 1807 (HUNTER, 1974), and both Barrow's and Barrett's data strongly suggest that early European paper, made by hand according to the Italian method, contains carbonate pigments which are alkaline. Probably the first reference to the presence of calcium carbonate in old European hand-made paper was made in 1935 by W. Budka in his article on the Balice papermill near Cracow. In addition to historical information about the mill (established in 1518-21) and its watermarks, Budka reported the presence of calcium carbonate at values of 3.0 and 3.7 per cent in two samples of paper made at the Balice mill and dated 1535 and 1553 respectively (BUDKA, 1935). But better known is a publication by F. Hanson who found that a book published in 1576 was made from various types of paper, some of which had aged badly, while others were in a good state of preservation. He showed that the well-preserved pages contained at least 2 per cent calcium carbonate (HANSON, 1939).

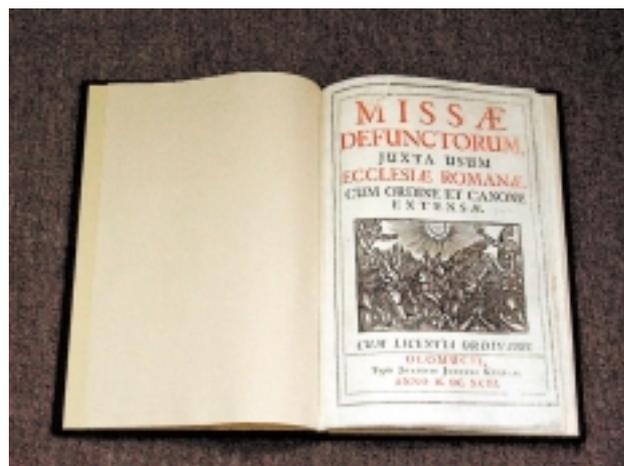
A part of our investigation into these questions, together with technological data present in historical sources, was published in friendly co-operation with Dr. John S.G. Simmons, Emeritus Fellow and sometime Librarian of All Souls College, Oxford (DĄBROWSKI, 2001). The addition of lime (i.e. calcium hydroxide) during the beating process may be considered to be the main 'secret' of early European paper-making carried out in accordance with the Italian method. The specific use of lime in the stamping process of paper manufacture was probably first mentioned by Francesco Maria Grapaldo in his work *De partibus aedium* printed in Parma, probably in 1494. Grapaldo's account of paper-making, which he includes in the ninth chapter of the second part of his book (*Bibliotheca*) shows a hands-on acquaintance with details of the craft which he presumably acquired at his local paper-mill in Parma – established in 1451 and noted for

the fineness of its products. This kind of alkaline paper-making, which was invented in medieval Italy, laid a solid foundation for the successful development of the European paper-making craft. For example, the use of lime in the beating process is referred to in the second half of the sixteenth century in the Regensburg Regulations. In the Italian method, the lime retained in the paper produced an alkalinity. However, the alkalinity of the paper was slowly neutralised by the reaction of atmospheric carbon dioxide with the lime present in the paper, producing calcium carbonate. So the technology involved particles of calcium carbonate (sometimes with an admixture of magnesium carbonate) developing in the paper without having been present in the original paper-making process, but arising naturally much later. It is highly probable that the fibres of early European papers made in accordance with the Italian method were loaded with minute particles of calcium carbonate. Moreover, a residue of the lime or calcium ions in the paper were able to cross-link the proteinaceous chains of the animal glue (gelatine) added to the paper during the sizing process. This interaction must have resulted in the insolubility of the animal glue and in a reduction of its hospitality to micro-organisms (DĄBROWSKI, 2001).

Having gained this knowledge, we started the manufacture of hand-made alkaline papers from long-fibred pulps, as well as the long-fibred *half-stuff* for filling losses in restored sheets of paper. Our papers meet the requirements for permanence of the standard ISO 9706. Accelerated ageing experiments, additionally conducted in dry air at temperatures ranging from 100 to 160°C, showed a slow rate of cellulose de-polymerisation, with traces of levulinic acid content: e.g. 3.5 ppm after 12 hours of ageing at 160°C (DĄBROWSKI, 1998). The levulinic acid content is proposed as a general indication of paper degradation, useful also in the case of paper containing a considerable amount of non-cellulosic substances (OYE, 1991).

Our paper is employed mainly as end paper, that which is used to finish the inside covers of books. It is also used to correct a defective sheet, or as a base paper for marbling, which is later on consumed in book binding. Together with the *half-stuff*, it is used by paper restorers in libraries and archives, and also in small and medium enterprises (SME's). During the conference some examples were shown, thanks to the kindness of Marzena Szczerkowska who, as a restorer and owner of the *VERSO* Paper and Leather Restoration Workshop at the town of Gniezno, employed our products in saving almost 1400 books damaged by water. One such example is shown here in Figure 1.

Our capabilities in research and hand-papermaking were also useful in the international project on restor-



**Figure 1.** Example of a book restored with the use of the ICP paper products (courtesy *VERSO*, Gniezno, Poland).

ing the ancient Coptic manuscripts in Deir al-Surian, Egypt (SOBCZYŃSKI, 2000). It required a better understanding of the technology used in ancient Arab paper-making (WEIR, 1957; BAKER, 1991).

We have also begun attempts to form thin paper for the conservation of silk fabrics. Close adherence to the contemporary conservation principle entailing the usage of conservation material containing the same raw material which was applied for making the historical objects leads to the conclusion that paper intended for the conservation of silk fabrics should be made of identical fibres. Therefore, in fibrous slurry for the sheet-forming process, genuine silk fibres prevail, and the preliminary results with this new conservation material are promising (POTOCKA, 2001).

The results discussed above are a presentation of the research opportunities in hand-papermaking, its history and technology, together with opportunities to recreate materials for restoration and for the study of paper deterioration. In this time of integrating research capacities across Europe, we hope to join other research groups in their efforts to save cultural heritage with our expertise in the field of paper.

### References

- BAKER D., 'Arab Papermaking', *The Paper Conservator*, **15**, 28–35, 1991.
- BARRETT T., 'Coded Messages in Historical Handmade Papers', *IPH Congress Book*, **11**, 86–91, 1996.
- BUDKA W., 'Papiernia w Balicach' (The Papermill in Balice), *Archeion*, **13**, 30–49, 1935.
- DĄBROWSKI J., 'Udział ICP w dziele ochrony i ratowania zbiorów' (Contribution of the ICP to the rescue and protection of library collections), in *Protection and Conservation of Library Collections. Proceedings of the National Conference*, Warsaw, 15–17 October 1998.
- DĄBROWSKI J. and SIMMONS J.S.G., 'Permanence of early European hand-made papers: some technological aspects and the evidence of F.M. Grapaldo (c. 1494) and of

the Regensburg Regulations (XVI 2/2 c.), *IPH Congress Book*, **12**, 255–263, 1998 [published 2001].

FAULHABER M. and PIETRZYK K., 'Über die Dauerhaftigkeit von Papier', *Wochenblatt für Papierfabrikation*, **84**, 147–153, 183–187, 1956.

GASPARINETTI A.F., 'Paper, Papermakers and Paper-mills of Fabriano', in *Zonghi's Watermarks (Aurelio & Augusto Zonghi – A.F. Gasparinetti)*, ed. E.J. LABARRE, The Paper Publications Society, Hilversum, 63-80, 1953.

HANSON F., 'Resistance of Paper to Natural Ageing', *Paper Industry and the Paper World*, **20**, 1157–1163, 1939.

HILLS R.L., 'Early Italian Papermaking, A Crucial Technical Revolution', in *Produzione e Commercio della Carta e del Libro secc. XIII–XVIII*, ed. S. CAVACIOCCHI, Istituto Internazionale di Storia Economica 'F. Datini' – Prato, Firenze, 73–97, 1992.

HUNTER D., *Papermaking, the History and Technique of an Ancient Craft*, Dover Publications, Inc., New York, 490, 1974.

OYE R., OKAYAMA T., AKAGI M. and OHNISHI T., 'Degradation of Paper – Indication of Degree of Degradation', in *Proceedings of the Appita 6th International Symposium on Wood and Pulping Chemistry*, Melbourne, vol.1, 397–400, 1991.

POTOCKA A.D., 'Papier jedwabny jako nowy materiał konserwatorski' (Silk Paper as a New Conservation Material), *Ochrona Zabytków*, **54**, 170–173, 2001.

SOBCZYŃSKI E., 'Christian Manuscripts from the Monastery Deir al-Surian (Egypt)', *Conservator-Restorers' Bulletin*, **11**, 1, 64–66, 137–138, 2000.

WEIR T.S., 'Some Notes on the History of Papermaking in the Middle East', *Papier Geschichte*, **7**, 43–48, 1957.

### Józef Dąbrowski\*

Pulp & Paper Research Institute (ICP)

P.O.Box 300, 90-950 Łódź, Poland

e-mail: icpndi@ld.onet.pl

Graduated in chemistry with a specialisation in pulp and paper technology at the Technical University of Łódź, Poland, and received his doctorate there in 1974.

In the years 1989–92, he was appointed assistant professor. Later on, he worked in the Pulp and Paper Research Institute (ICP) as scientific secretary. His chief current research interest is in the permanence of hand-made and machine-made papers. In 1994, he was elected a corresponding member of the International Association of Paper Historians (IPH) and introduced into the IPH Council.

### Henryk Gonera and Marzanna Marcinkowska

Pilot Plant Department,

Pulp & Paper Research Institute (ICP)

ul. Świętojańska 4/6, 93-493 Łódź, Poland

e-mail: icpdp@ld.onet.pl

### Anna Dorota Potocka

Academy of Fine Arts

ul. Wyrbrzeże Kościuszkowskie 37

00-379 Warszawa, Poland

See more of "mcm Manus Paper Conservation" on Facebook. Log In. or. Create New Account. See more of "mcm Manus Paper Conservation" on Facebook. Log In. Forgotten account? The painstaking work of art restorers, who remove decades of dulling dirt and dust or repair damaged works, is meant to help art stand the test of time by keeping time at bay. The painstaking work of art restorers, who remove decades of dulling dirt and dust or repair damaged works, is meant to help art stand the test of time by keeping time at bay. mcm Manus Paper Conservation. 29 August 2019. Basic and good. Learn more about the history of the vandalism, the different attempts at conservation, and more: See more. The great thing about handmade paper is that its so versatile in use and yet no matter what it's purpose, it adds a distinctively creative element. My name is Mona Majorowicz and I have been in the art and framing industry for over 20 years. I am an animal artist (meaning I paint critters) who works primarily in Oil Pastel or Water Soluble Pencil. Linters are traditionally used in the manufacture of paper and as a raw material in the manufacture of cellulose. In the UK, linters are referred to as "cotton wool". Ten Steps To Making Paper. Garbage Disposal For The Serious Hnadmade Paper Maker - If You Make Big Batches Often This Is The Way To Go. Connie makes enough batches that she uses a 1 horsepower garbage disposal unit specifically for the job.